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# Southern Hairy-nosed Wombats (*Lasiorhinus latifrons*) in Western Australia: out of sight, out of mind

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**Abstract**

Southern Hairy-nosed Wombats (*Lasiorhinus latifrons*) inhabit a fragmented distribution across the arid and semi-arid regions of south-central South Australia and south-eastern Western Australia. Although significant research has been undertaken on the South Australian population, there have never been any dedicated broad-scale surveys of Southern Hairy-nosed Wombats in Western Australia. To correct this, the aims of this study were to map the distribution and population density of the Western Australian population of Southern Hairy-nosed Wombats. We undertook two field surveys to speak with landholders in the region and to map and measure the attributes of selected wombat warrens. We then analysed high resolution satellite imagery of the area between the South Australian border and Balladonia, Western Australia, and from the coastline to the transcontinental railway. The distribution of wombats in Western Australia stretches from the South Australian border to Caiguna, and northwards from the Eyre Highway for approximately 75 km. All landholders in the region believe that wombat numbers have been increasing over the past few decades. Follow-on research needs to be undertaken in the decades ahead to determine any population trends.

## Introduction

The effective management of species requires a good understanding of its population dynamics, including its distribution, abundance, population trends and the factors which influence these fundamental traits (Fryxell *et al.* 2014). However, whilst the distribution of a species can cross human political borders (states, territories or nations), research into, and management of, wildlife is often undertaken differently in different jurisdictional regions. These divergent approaches to wildlife management have the potential to result in an incomplete assessment of where a species can be found and/or how many individuals there might be, with the potential for improper management at the species-wide scale (Bischof *et al.* 2016).

The Southern Hairy-nosed Wombat (*Lasiorhinus latifrons*) is the faunal emblem of South Australia (SA). Whilst wombats currently inhabit a fragmented distribution across the arid and semi-arid regions in the south-central areas of SA (Fig. 1), at the time of European settlement they could be found from Euston in New South Wales to as far west as Balladonia in Western Australia (WA) (Swinbourne *et al.* 2017). Their numbers declined dramatically across their entire range in the late 19th and early 20th centuries, most likely as a result of competition from rabbits, the modification of land for agriculture and human persecution.

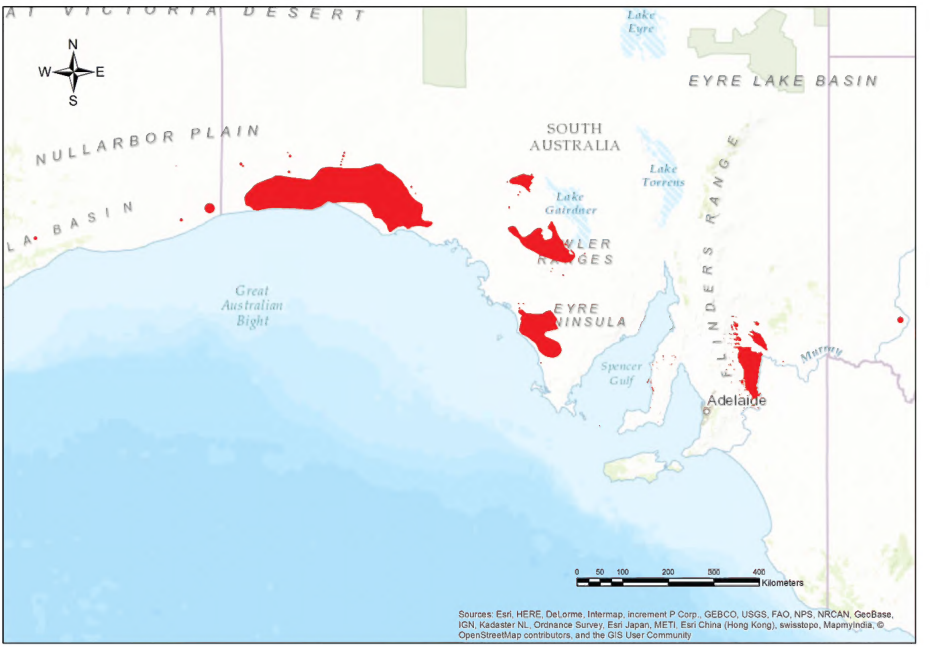


**Figure 1**. The distribution of Southern Hairy-nosed Wombats (*Lasiorhinus latifrons*) as at the latest published survey for each region. However, this map is significantly out of date, as the information for the Gawler Ranges and Eyre Peninsula regions has not been updated since the 1980s, and there has been no dedicated survey to determine the distribution and abundance of wombats in Western Australia.

Indeed, in WA by the mid-20th century some naturalists were doubting whether wombats had ever been present in the state in significant numbers during European settlement (Jenkins 1962; Lowry 1967). One report by the WA Government's Department of Environment and Conservation even suggested that wombats may have been extinct in the state for 30,000 years (Abbott 2009). Despite this, Southern Hairy-nosed Wombats were known to exist in WA in the 1980s, as a biological survey of the Nullarbor Plain region located warrens in the vicinity of Eucla, as well as reporting on earlier sightings of wombats at locations such as Balladonia and Rawlinna (McKenzie & Robinson 1987). However, the full extent of the wombat population in WA remained unknown.

The paucity of information regarding wombats in WA is, in one respect, understandable. The Nullarbor Plain, where wombats could be found in the early years of European settlement, contains no settlements other than a few highway roadhouses and isolated agricultural properties. The only major road in the area, the Eyre Highway, was not completely sealed until 1976 (Edmonds 1997), and all access roads between the highway and the transcontinental railway line remain unsealed to this day. Despite these difficulties, occasional reports have been published which support the ongoing presence of wombats at several locations in the region, including Rawlinna station (St. John & Saunders 1989), Caiguna (Lowry 1967), Mundrabilla (Aitken 1973) and Forrest (St. John & Saunders 1989).

The dispersed geographic extent of these reports suggests that wombats may once have been widespread in WA. However, whilst numerous surveys have been undertaken in SA, no broad-area surveys have ever been published of the WA wombat population. Further, whilst a management plan was formulated for wombats in SA (St. John & Saunders 1989), including distribution maps and an overall population estimate, no account was made for wombats in WA and they were not included in the overall abundance estimate. As a consequence, if Southern Hairy-nosed Wombats are present in WA in significant numbers then our current understanding of the species-wide distribution and abundance would almost certainly understate the true situation.

To update our knowledge of the species-wide distribution and abundance of Southern Hairy-nosed Wombats in WA we undertook two field surveys to south-eastern WA to ascertain the likely wombat population in the region. The field surveys included holding discussions with landholders and locals in the area, as well as marking the position and measuring the key attributes of warrens in several locations. Based on the knowledge we gained from the field surveys, we then used high resolution satellite imagery to map the full distribution of Southern Hairy-nosed Wombats in WA and to estimate their overall abundance.

## Methods

### Warren counts and classing

We conducted two field surveys (May 2016 and May 2017) of the Nullarbor Plain region of WA between the SA border westwards to Balladonia, and from the coastline north to the transcontinental railway, to speak

with landowners about wombats on their properties and to survey selected warrens in the area (Fig. 2). Warren positions were marked with a hand-held GPS (Garmin eTrex 10) and their sizes were estimated by pacing across the diagonal axis. The total number of burrows and the number of active burrows in each warren were counted. Burrows were assessed as active if there were signs of recent digging (within the past few days), wombat footprints, fresh scats or visual or audible signs of a wombat in the burrow. Measured warrens were separated into four size classes: small (0–5 m), medium (6–15 m), large (16–35 m) and very large (> 35 m) (Tiver 1980, 1981; McGregor & Wells 1998; St. John 1998; Taggart & Ostendorf 2012).

**Warren surveys using satellite imagery**

Wombat warrens can be visible on satellite images (Löffler & Margules 1980; Swinbourne *et al.* 2018b). Using freely-available, high resolution (>1 m) satellite imagery on Google Earth and Bing Maps, we used ArcMap version 10.3.1 to overlay a grid of 1 km$^2$ cells oriented north-south over satellite imagery of the Nullarbor Plains region between the transcontinental railway and the coast, and from the SA border to 125°E. Lines of cells oriented north-south and east-west at 5 km intervals were selected from the grid and inspected for the presence of wombat warrens. The cells containing wombat warrens which were closest to the edge of the grid were highlighted, and an

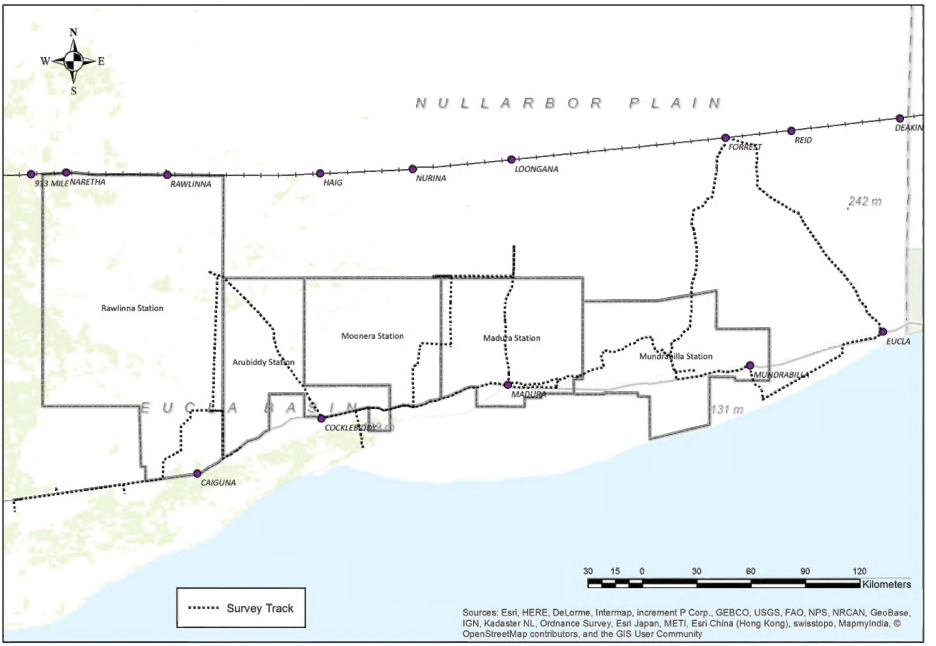


**Figure 2**. Nullarbor Plains region of Western Australia showing the main agricultural properties in the area and our survey track.

outline distribution of the wombat population was drawn.

Using the ArcMap Sampling Design tool, we randomly selected 1,000 grid cells from within the outline distribution for detailed analysis. For each selected grid cell, the date of the imagery was recorded, the presence or absence of warrens was noted and all warrens were counted and their diameter measured. The raw count of warrens for each size class in each grid square was then multiplied by indices to correct for warrens (small warrens in open grassland x 1.3, in scrubland x 1.6; medium warrens in open grassland x 1.05, in scrubland x 1.25; large and very large warrens - no change) which may not be visible in the satellite imagery (e.g. under vegetation) (Swinbourne *et al.* 2018b).

## Results

We found wombats from the SA border westwards to Caiguna (Fig. 3), a distance of ~350 km, and from the Eyre Highway northwards for ~75 km. The distribution is patchy, with the highest population densities occurring in the east near Eucla and Mundrabilla within 30 km of the Eyre Highway. In general, wombats only occur to the north of the Eyre Highway, except for a colony mid-way between Cocklebiddy and Madura, and only

**Figure 3**. Southern Hairy-nosed Wombat mother and joey captured on a motion-activated camera at the entrance to their burrow near Caiguna on the boundary between Rawlinna and Arubiddy stations (warren location 32.189°S, 125.609°E). This represents the current western edge of the wombat distribution. Photo: Michael Swinbourne.

occur 'above the escarpment', except for the area between the Mundrabilla roadhouse and Mundrabilla station homestead. There is a small outlying colony adjacent to the transcontinental railway line, ~5 km to the south-east of the town of Forrest (30.85°S, 128.11°E), separated from the main population group by ~30 km (Fig. 4).

During the ground surveys we spoke to the landholders or station managers on Rawlinna, Arubiddy, Madura/Moonera and Mundrabilla stations (Fig. 2) and marked the position and measured the attributes of 492 warrens. Warrens varied in size from 1–38 m (mean = 7.5 m, S.D. = 5.5), and contained a total of 1,140 burrow entrances, of which 831 were assessed as active (73%; see Table 1). The mean warren density in the populated areas was 23.67 warrens/km$^2$ (S.D. = 18.57), with a maximum warren density of 96 warrens/km$^2$ in the area ~15 km north-west of Eucla.

## Discussion

This study provides the first in-depth assessment of the distribution and abundance of Southern Hairy-nosed Wombats in WA. Whilst previous broad-scale studies of the Southern Hairy-nosed Wombat population have described the SA population in detail, information on the WA population has

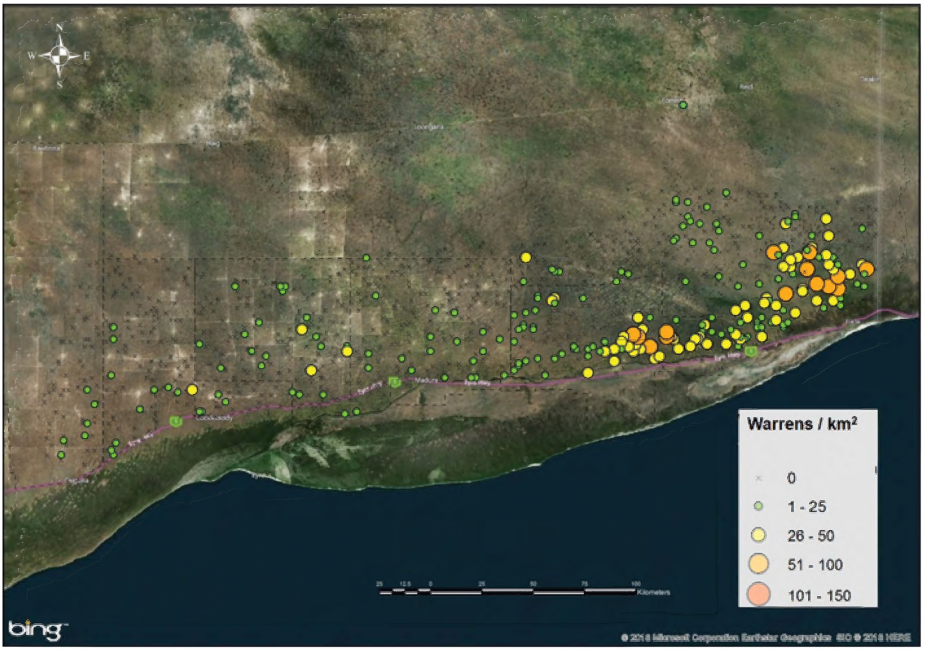


**Figure 4**. Distribution and local area abundance of Southern Hairy-nosed Wombats in Western Australia as of July 2017. Note the patchy distribution, with the most densely populated region in the south-east between Eucla and Madura, and large areas with few to no wombats present scattered throughout the overall distribution. Each point showing zero warrens is the centre of a 1 km$^2$ grid which contains no warrens.

**Table 1**. Characteristics of all warrens of different size classes which we measured during the field surveys.

| Size | Number surveyed | Proportion of total | Mean no. of active burrows (S.D.) | Mean no. of total burrows (S.D.) |
|---|---|---|---|---|
| Small (0–5 m) | 229 | 0.47 | 0.86 (0.58) | 1.22 (0.65) |
| Medium (6–15 m) | 221 | 0.45 | 2.06 (1.52) | 2.90 (1.71) |
| Large (16–35 m) | 41 | 0.08 | 4.24 (2.42) | 5.22 (2.58) |
| Extra | 1 | 0.00 | N/A | N/A |
| Total | 492 | 1.00 | 1.69 (1.62) | 2.32 (1.87) |

generally been incidental only. Apart from a few one-off reports (Jenkins 1962; Lowry 1967), the only studies which reported on wombats in WA located warrens only in the far east near Eucla (McKenzie & Robinson 1987), as well as describing *"outlying colonies… stretching to… Mundrabilla"*, and that *"colonies have been reported from as far west as Caiguna, but I have not seen these"* (Aitken 1973, p. 13).

Our findings show that, whilst the WA wombat population has remained unsurveyed until this study, it is not an inconsequential population group and it does represent a substantial proportion of the overall species distribution and abundance. The geographic extent of the WA wombat population is similar to that of the Nullarbor/Far West Coast population on the SA side of the border, and it occupies similar geographic and climatological niches.

Whilst the evidence clearly shows that the distribution of Southern Hairy-nosed Wombats in WA is substantial, estimating their abundance can be difficult as wombats are nocturnal and fossorial. All regional and species-wide abundance estimates to date have relied on a proxy measure – an index of the number of wombats per active burrow. While recognising the limitations with such an approach (Taylor 1998), given the number of warrens that we observed during both our field surveys and in the satellite imagery, and using the same calculations which were used in previous studies to estimate wombat abundance in SA (0.5 wombats/active burrow) (St. John 1998), the overall Southern Hairy-nosed Wombat abundance in WA at the time of this study (2017) would have been ~90,000 individuals. This is 2–3 times larger than the most recent published data for the SA Murraylands region (McGregor & Wells 1998).

Whether the wombat population in WA is increasing or decreasing cannot be definitively determined given that there have been no earlier detailed assessments for comparative purposes. However, given that the 1984 biological survey of the Nullarbor Plain region of WA only located wombats in the far south-east of the state (McKenzie & Robinson 1987), and that we located warrens in numerous locations well outside that area, it appears that there has been a substantial increase in both the species distribution and abundance over the past few decades. This view was also expressed by the landholders in the region during the conversations we held with them

on our field surveys. For example, in the 1970s and 80s the wombat population on Mundrabilla Station, 100 km from the SA border, was thought to be in isolated colonies only (Aitken 1973; St. John & Saunders 1989), but had been increasing on the property ever since, and that the distribution has been expanding both westwards and northwards (B. Campbell, station owner, pers. comm.). Today, the wombat population density on Mundrabilla Station directly above the escarpment is amongst the highest in the state. The number of wombats in some parts of the station is now so high that the station owner stated that they no longer mustered cattle on motorbikes because of safety concerns over wombat burrows. In the past 15 years, for the first time in living memory wombats have also appeared 'below the escarpment', and they now occur throughout the area to the north of the Eyre Highway between the roadhouse and the station homestead (20 x 2 km) (Fig. 5).

The most densely populated region in the state encompasses the area to the north of Mundrabilla and Eucla within a roughly triangular shape with a base of ~30 km along the SA border, northwards from a point ~10 km north of Border Village (to the north of the mallee scrublands), then south-westwards for ~200 km to Madura (31.90°S, 127.02°E). Outside of this area the population is unevenly distributed, with some areas containing no wombats at all, interspersed with regions of relatively high population density, such as along the boundary between Arubiddy and Rawlinna stations (longitude 125.56°E) to the north of Caiguna.

At the local scale, this patchy distribution appears to be heavily influenced by topography. Much of the Nullarbor Plain consists of a mosaic of small catchments, each draining to a depression which has undergone colluvial in-filling to form a claypan up to 1 km wide (Mitchell *et al.* 1979). During both our ground surveys and

**Figure 5**. Southern Hairy-nosed Wombat warren in bluebush scrub 'below the escarpment' just off the Eyre Highway, ~10 km to the east of the Mundrabilla homestead (warren location 31.838°S, 127.943°E). Photo: Michael Swinbourne.

the analysis of the satellite imagery we noticed that these depressions were strong predictors for warren locations, with warrens often being concentrated around the edges of the claypan (Fig. 6). This phenomenon has previously been described in SA (Aitken 1973; Löffler & Margules 1980). We suggest that there are several reasons for this observation. First, the soil in the claypans is deeper and more friable than on the surrounding limestone ridges and is therefore more conducive to burrow construction. Second, the limited rain which does fall tends to drain into these depressions, promoting more lush growth of the *Eragrostis setifolia* grasslands (Mitchell *et al.* 1979), thus increasing feed availability. The concentration of warrens around the edges of the depression rather than in the centre is most likely to avoid the possibility of flooding on the floor of the claypan which can occur during periods of high rainfall (Geoscience Australia 2017).

These claypan depressions are widespread across the entire Nullarbor karst region and extend up to 100 km north of the transcontinental railway. If these areas are favoured by wombats, as appears likely, then there may be scope for the wombat population to expand beyond its current distribution, as well as to occupy any vacant claypans within the current distribution.

Further evidence for this potential can be found in an isolated population

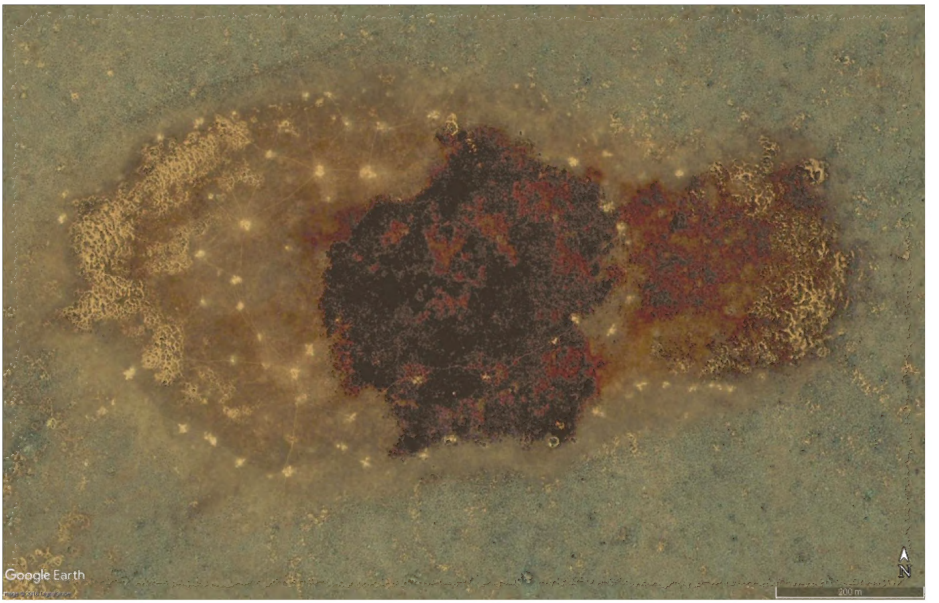


**Figure 6**. Satellite image showing wombat warrens constructed around the edges of a claypan depression ~45 km north-west of Eucla. The blotches in the image are the warrens with their interlinking trails. The dark area in the centre of the image is the lowest point of the depression, whilst the lighter areas to the north and south are the limestone rises surrounding the claypan. Note the lack of warrens in these areas (source: Google Earth 7.3.1.4507. 31.336°S, 128.624°E, DigitalGlobe 19 March 2014, accessed 17 March 2018).

that we located ~5 km south-east of the railway town of Forrest (30.85°S, 128.11°E), ~30 km to the north of the main population group. This distance is probably too great for the wombats to have recently dispersed to the area, and there were unconfirmed reports of wombats in the area in the 1980s (St. John & Saunders 1989). Therefore, it is most likely that the Forrest colony is a remnant group that was left behind when the main population underwent a contraction at some time in the past. The area between Forrest and the main wombat population to the south also contains a large number of claypan depressions (Benbow & Hayball 1992), which suggests that this area may also likely to be suitable for wombats. If, as appears likely, the species distribution in WA is expanding both northwards and westwards, there is clear potential for wombats to move into these areas, and a monitoring program focused on these areas could provide important evidence of population trends.

Why the wombat population contracted in the past, and why it appears to be expanding now, cannot be determined definitively. However, the available evidence suggests that it is most likely related to rabbits. Rabbits are significant competitors of wombats (Cooke 1998), and the rabbit plagues of the late 19th and early 20th centuries have been implicated in the decline of wombats across their entire distribution (Swinbourne *et al.* 2017). Wombat numbers also appear to have been increasing in other regions (Swinbourne *et al.* 2018a) coincident with a long-term reduction in competitive pressure from rabbits as a result of myxomatosis and the rabbit haemorrhagic disease virus (calicivirus) (Cooke 1998; Mutze *et al.* 2018). During our field surveys we noted that much of the Nullarbor Plain is heavily infested with rabbit warrens (Fig. 7), the majority of which now appear to be completely or mostly unoccupied, suggesting that the rabbit population in the region has declined significantly in recent years. If rabbits remain under effective control, and other factors such as climate remain favourable, we predict that wombat numbers in WA will continue to increase and that they will expand into other areas where they are not currently found.

## Conclusions and recommendations for further research

The findings from this study show that there is a large population of Southern Hairy-nosed Wombats in WA which is comparable with other population groups in SA, and which forms a significant proportion of the overall species abundance. Whilst it appears likely that there has been a significant increase of wombat numbers in WA over the past few decades, it is also likely that previous distribution maps and estimates of wombat numbers understated the true situation by not fully accounting for this population group. This has implications for wombat management at both the regional and species-wide scales, and analysis should be undertaken to determine if any changes should be made to wombat conservation status and management policies. Importantly, given that this is the first dedicated study to provide a detailed assessment of the distribution and abundance of wombats in WA, we would strongly recommend that follow-on studies be undertaken to establish any population trends.

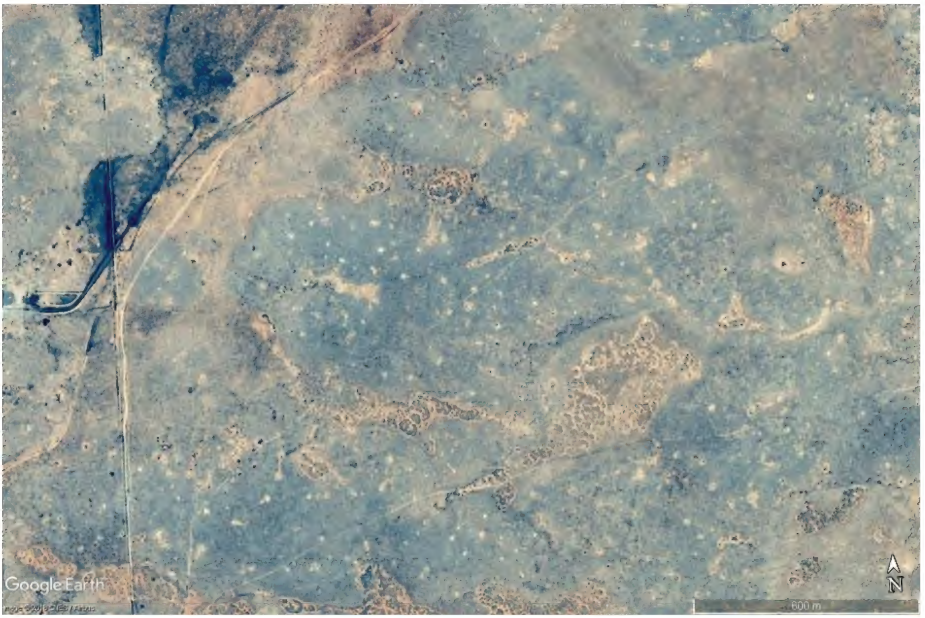


**Figure 7**. Satellite image of the area 3 km north-east of the town of Forrest, showing the large number of rabbit warrens (pale spots on the image) typical for much of the region. During our field surveys we noted that most of the rabbit warrens on the Nullarbor were either largely or completely unoccupied, which suggests that the population may have declined substantially (source: Google Earth 7.3.1.4507. 30.838°S 128.137°E, CNES/Airbus 24 October 2015, accessed 17 March 2018).

**Acknowledgements**

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**Conflicts of Interest**

The authors declare no conflicts of interest.

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# Shorebird populations from 1995 to 2020 at Woodman Point, Western Australia

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**Abstract**

Shorebird populations at Woodman Point, which is part of the East Asian-Australasian Flyway, have been monitored by many observers for 25 years from 1995 to 2020. Regular surveys conducted during this period, together with additional historical records, have measured the number of species, their abundance and duration of their visits. Between 1995 and 2020 the population has declined by 84%. There has been a decline in species diversity, a reduction in flock size and stays have been shorter. The decline of the migratory shorebird populations is attributable to diminishing overseas habitat and local disturbance factors. The decline of Australian breeding shorebirds is due to local disturbances. The surveys recorded 21 species of migratory shorebirds and eight species of Australian breeding shorebirds, some of which are Critically Endangered.

## Introduction

Woodman Point is located on the West Australian coast, 10 km south of Fremantle, at 32°08'S, 115°44'E (Fig. 1). It is situated within the Woodman Point Regional Park which is an important nature conservation reserve (Woodman Point Regional Park Management Plan 2010). The reserve is a significant migratory shorebird site on the Perth metropolitan coastline between Yanchep and Rockingham.

Migratory shorebirds use flight paths referred to as 'flyways' and Australia is part of the East Asian-Australasian Flyway (EAAF). This flyway extends from breeding grounds in the Russian tundra, Mongolia and Alaska southwards through east and south-east Asia, to non-breeding areas in Indonesia, Papua New Guinea, Australia and New Zealand. The EAAF relies on a system of highly productive wetlands that allow migratory shorebirds to rest and feed, building up sufficient energy to undertake their migration journeys. Most migratory shorebirds make an annual return journey of many thousands of kilometres between their breeding grounds in the northern hemisphere and their non-breeding grounds in the southern hemisphere (Weller & Lee 2017). The Woodman Point Regional Park provides a stopover for a number of threatened shorebirds as listed in the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). These include Eastern Curlew (Critically Endangered), Great Knot (Critically Endangered), Greater Sand Plover (Vulnerable) and Red Knot (Endangered).

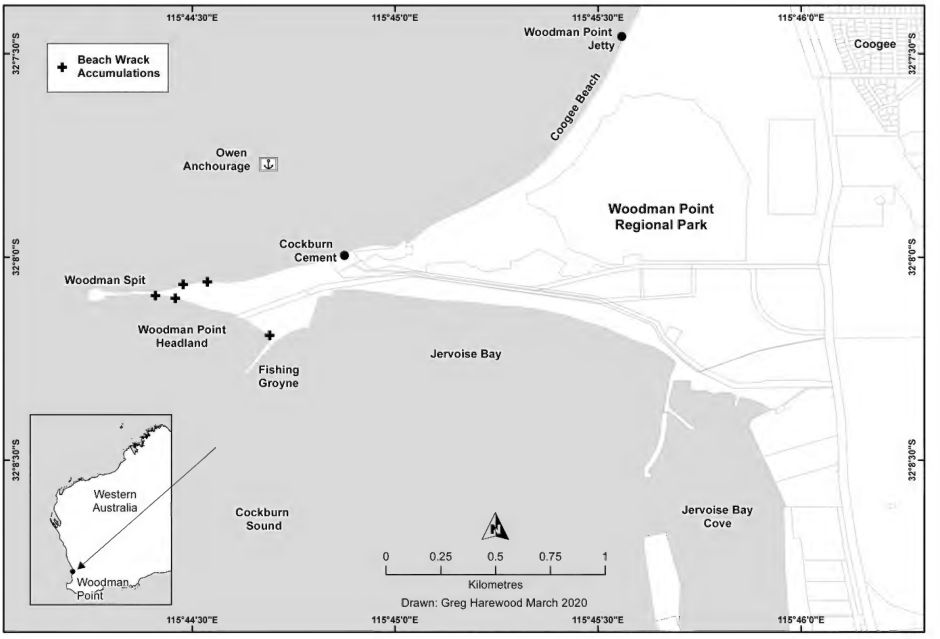


**Figure 1**. Map of Woodman Point Reserve.

The Woodman Point headland extends out into Owen Anchorage and consists of low dunes and two limestone groynes, Fishing Groyne and Woodman Spit (Figs. 1, 2). The soils are Quindalup Sands, consisting of quartz grains and fragments of seashells (McArthur & Bettenay 1960). Incoming swells are diffracted by Garden Island and Rottnest Island (Rogers & Associates 1995), reducing wave energy. This results in low energy beaches and accumulations of beach wrack. Beach erosion over winter often prevents access to Woodman Spit though sand accretion takes place in the other seasons, enabling access.

The plateau at the end of Woodman Spit is slowly eroding and on the seaward side has been transformed into a shelf of weathered limestone rocks favoured by sea and shorebirds, which acts as a refuge when disturbance levels are high (Fig. 3). Its location in Cockburn Sound provides a sheltered environment and protection from prevailing winds, which differs significantly from the adjoining coastline. The extensive seagrass (*Posidonia*) beds in Cockburn Sound die off and wash ashore to form beach wrack banks providing a source of food. Thus, the site is attractive to shorebirds migrating along the West Australian coast as it provides shelter, food and a range of different shorebird habitats.

The records of shorebird sightings collected over 25 years have been analysed to detect any change in shorebird populations. Shorebirds were common when they were monitored

**Figure 2**. Woodman Spit, looking towards the sea and platform. Photo: Marcus Singor.

**Figure 3**. Eroding platform at the end of Woodman Spit, shorebirds divert here when disturbance levels are high. Photo: Marcus Singor.

at Woodman Point between 1995 and 1998 (Singor 1999).

## Methods

Most surveys were conducted by the author in the early morning as this facilitates accurate counting and avoids unwanted shorebird movements caused by disturbance. Counting commenced at the Cockburn cement works at the end of Woodman Point View and followed the beach along Owen Anchorage (Fig. 4) out to the small plateau at the end of Woodman Spit (Fig. 3), then back along the seaweed covered beach to Woodman Point (the Fishing Groyne). The surveys continued along the rocky shoreline facing Jervoise Bay and finished at the Cockburn cement works (Fig. 1).

Shorebird records from Bryan Barrett

**Figure 4**. Woodman Point, narrow beach overlooking Owen Anchorage. Photo: Marcus Singor.

(deceased) for the period 1986 to 1994 provide an historical context and support the findings from the main survey period. Several of the oldest records from the early 1980s were obtained from the Shorebird2020 records in Birdlife Australia's Birdata database (Birdata 2020) (Alcorn 1994). Shorebird records have been supplemented with data obtained from the many observers who frequently visit Woodman Point. Observers who have contributed at least five surveys are listed in Table 1; those who have contributed fewer surveys are acknowledged in the Acknowledgements. The high number of shorebird species (18) sighted during the year 2020 may be attributed to the increased number of surveys (82) conducted at Woodman Point whilst the Covid-19 restrictions were in place.

Annual data comprises all the observations collected between January to December of that year. Only five surveys were conducted in 2003. The term Australian summer relates to the months December, January and February and the Australian winter months are June, July and August.

**Table 1**. Contributors of shorebird data from Woodman Point.

| | Observation years | Number of surveys |
|---|---|---|
| John Baas | 2018–2020 | 12 |
| Bryan Barrett | 1986–1994 | 42 |
| Laurie Boyle | 2013–2015 | 17 |
| Christine Chester | 2017–2020 | 7 |
| Ken Glasson | 2018–2020 | 9 |
| John Graff | 2008, 2012, 2013 | 5 |
| Geoffrey Groom | 2016–2020 | 30 |
| Les Harris | 2004–2005 | 14 |
| Peter Lowe | 2018–2020 | 9 |
| Robyn Pickering | 2006–2013 | 28 |
| Joseph Russell | 2018, 2020 | 6 |
| Marcus Singor | 1995–2020 | 234 |

## Results

The years in which each shorebird species was observed, and the highest annual number recorded are shown in Table 2. The trend in numbers is shown

**Table 2**. Highest annual shorebird count at Woodman Point, 1995–2020.

| | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Years present | Highest count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Migratory shorebirds** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Grey Plover | 10 | 13 | 10 | 8 | 6 | 8 | 6 | 5 | 4 | 5 | 7 | 4 | 5 | 6 | 4 | 11 | 8 | 7 | 12 | 7 | 7 | 6 | 8 | 4 | 8 | 6 | 26 | 13 |
| Pacific Golden Plover | | | | | 5 | 13 | 9 | P | | | | P | | | | P | | | | | | | | 4 | | 1 | 8 | 13 |
| Greater Sand Plover | 3 | 8 | 4 | 2 | 1 | 1 | 2 | P | | 2 | 1 | 1 | | 2 | | 1 | 4 | 1 | P | 1 | 2 | | 1 | 2 | | 1 | 21 | 8 |
| Whimbrel | | | | | | P | P | | | 1 | P | | | | | | 1 | | | 1 | 1 | 1 | 1 | | | 1 | 10 | 1 |
| Eastern Curlew | | | 1 | | | | | 1 | | | | | | | | | | 1 | | | | | | | | 1 | 4 | 1 |
| Bar-tailed Godwit | 7 | 2 | | | | P | P | | | 2 | | | | | 1 | 1 | 3 | | | | | 1 | | | | 1 | 10 | 7 |
| Ruddy Turnstone | 23 | 24 | 33 | 22 | 16 | 18 | 12 | 10 | 10 | 15 | 6 | 6 | 6 | 8 | 10 | 13 | 13 | 5 | 5 | 5 | 3 | 8 | 9 | 9 | 15 | 8 | 26 | 33 |
| Red Knot | | | 3 | 10 | 1 | | | P | | | | | | | 1 | | 2 | | 8 | 1 | 1 | 1 | | 1 | 2 | 7 | 13 | 10 |
| Great Knot | 7 | 64 | 30 | 20 | 11 | 7 | 3 | P | | 1 | 2 | 2 | 7 | 19 | 1 | 25 | 27 | 6 | 6 | 2 | 4 | 2 | 2 | 3 | 6 | 11 | 25 | 64 |
| Sharp-tailed Sandpiper | 1 | | 6 | | | | | 3 | | | | | | | | | | | | | | | | | 2 | 2 | 5 | 6 |
| Curlew Sandpiper | 1 | 1 | 1 | | | 59 | 6 | | | | | | | | | | | P | | | | | | | | | 6 | 59 |
| Red-necked Stint | 27 | 8 | 9 | 5 | 4 | 8 | 17 | 5 | 6 | 21 | 3 | 1 | 3 | 4 | 3 | 9 | 4 | 3 | 1 | 4 | 2 | 4 | 1 | 3 | 5 | 6 | 26 | 27 |
| Sanderling | 27 | 20 | 11 | 7 | 5 | 10 | 5 | 1 | | 1 | 1 | | | 5 | 2 | | | P | 2 | 1 | 2 | | 3 | 1 | 3 | 2 | 20 | 27 |
| Terek Sandpiper | 1 | | 1 | | | 1 | | | | | | | | | 1 | | | | | | | 1 | | | 1 | 1 | 7 | 1 |

**Table 2**. (cont.).

| | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Years present | Highest count |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Sandpiper | 1 | 1 | 2 | 1 | 1 | 1 | 1 | P | | | | | | | | | | 1 | | | | | 2 | | 1 | 1 | 12 | 2 |
| Grey-tailed Tattler | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 4 | 1 | | | 1 | 1 | 1 | 2 | | 1 | 1 | | | | | | 2 | 3 | 18 | 4 |
| Common Greenshank | | 1 | 2 | 5 | 2 | P | 1 | P | | | | | 1 | 2 | 1 | | 1 | P | 1 | | 3 | | | 1 | | | 15 | 4 |
| Species richness | 12 | 11 | 14 | 10 | 11 | 14 | 13 | 13 | 4 | 9 | 7 | 6 | 6 | 8 | 10 | 8 | 9 | 11 | 9 | 8 | 9 | 8 | 8 | 9 | 10 | 15 | | |
| **Australian-breeding shorebirds** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aust. Pied Oystercatcher | 7 | 14 | 7 | 12 | 5 | 4 | 8 | 4 | 1 | 3 | 3 | 1 | 4 | 4 | 4 | | 4 | 5 | 4 | 6 | 8 | 9 | 4 | 5 | 4 | 4 | 25 | 14 |
| Sooty Oystercatcher | 1 | 1 | | | | | | | | | | | 1 | | | | | 1 | | 1 | 1 | | 1 | | | | 7 | 1 |
| Banded Stilt | | | 1 | 4 | | | | P | | 4 | 10 | | | | | | | | | | 1 | | | 10 | 1 | | 8 | 10 |
| Red-necked Avocet | | 9 | | | | | P | | | | | | | 4 | | | | 8 | | 3 | 3 | | | 2 | 2 | 5 | 9 | 9 |
| Pied Stilt | | 15 | 6 | | | | | | | | | | | | 2 | | | 1 | 1 | | | 2 | | 6 | | | 7 | 15 |
| Red-capped Plover | 18 | 28 | 28 | 49 | 28 | 37 | 22 | 17 | 7 | 21 | 18 | 14 | 23 | 22 | 8 | 12 | 9 | 9 | 3 | 11 | 8 | 12 | 20 | 4 | 7 | 8 | 26 | 49 |
| Species richness | 3 | 5 | 4 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | 5 | 3 | 4 | 5 | 3 | 3 | 5 | 4 | 3 | | |
| Total species | 15 | 16 | 18 | 13 | 13 | 16 | 16 | 16 | 6 | 12 | 10 | 8 | 9 | 11 | 13 | 9 | 11 | 16 | 12 | 12 | 14 | 11 | 11 | 14 | 14 | 18 | | |

P=Present

by providing the highest count for 5-year increments for the period 1980 to 2019 (Table 3).

## Migratory shorebirds

### Grey Plover *Pluvialis squatarola*

The Grey Plover is seen on a regular basis at Woodman Point and has been present for each of the past 25 years (Table 2). Their numbers vary from year to year but in general they stay within the range of four to 10 birds. The Grey Plover population trends for the period 1983 to 2020 are shown in Fig. 5. Grey Plover arrive from late August onwards often still showing partial breeding plumage: extensive

**Table 3**. Highest population counts measured in successive 5 year periods at Woodman Point. Present indicates the species was reported in the 5 year block although numbers were not recorded.

| | 1980–1984 | 1985–1989 | 1990–1994 | 1995–1999 | 2000–2004 | 2005–2009 | 2010–2014 | 2015–2019 |
|---|---|---|---|---|---|---|---|---|
| **Migratory shorebirds** | | | | | | | | |
| Grey Plover | 25 | 13 | 12 | 13 | 8 | 7 | 12 | 8 |
| Pacific Golden Plover | | | | 5 | 13 | Present | Present | 4 |
| Greater Sand Plover | 1 | Present | 1 | 8 | 2 | 2 | 4 | 2 |
| Whimbrel | 1 | | 1 | | 1 | Present | 1 | 1 |
| Eastern Curlew | | | | 1 | 1 | | 1 | |
| Bar-tailed Godwit | 1 | 2 | 1 | 7 | 2 | 1 | 3 | 1 |
| Ruddy Turnstone | 25 | 18 | 16 | 33 | 18 | 10 | 13 | 15 |
| Red Knot | 24 | 22 | 4 | 10 | Present | 1 | 8 | 2 |
| Great Knot | 100 | 87 | 2 | 64 | 7 | 19 | 27 | 6 |
| Sharp-tailed Sandpiper | 3 | Present | | 6 | 3 | | | 2 |
| Curlew Sandpiper | 1 | | 5 | 1 | 59 | | Present | |
| Red-necked Stint | 13 | 65 | 34 | 27 | 21 | 4 | 9 | 5 |
| Sanderling | 60 | 54 | 24 | 27 | 10 | 5 | 2 | 3 |
| Terek Sandpiper | 2 | 1 | 1 | 1 | 1 | 1 | | 1 |
| Common Sandpiper | 3 | 2 | | 2 | 1 | | 1 | 2 |
| Grey-tailed Tattler | 2 | 1 | 1 | 3 | 4 | 1 | 2 | 2 |
| Common Greenshank | 1 | | 1 | 5 | 1 | 2 | 1 | 3 |
| **Australian-breeding shorebirds** | | | | | | | | |
| Australian Pied Oystercatcher | 53 | 36 | 21 | 14 | 8 | 4 | 6 | 9 |
| Sooty Oystercatcher | 4 | 2 | 1 | 1 | | 1 | 1 | 1 |
| Banded Stilt | 15 | Present | | 4 | 4 | 10 | | 10 |
| Red-necked Avocet | 24 | | 1 | 9 | Present | 4 | 8 | 3 |
| Pied Stilt | | | | 15 | | 2 | 1 | 6 |
| Red-capped Plover | 33 | 21 | 25 | 49 | 37 | 23 | 12 | 20 |

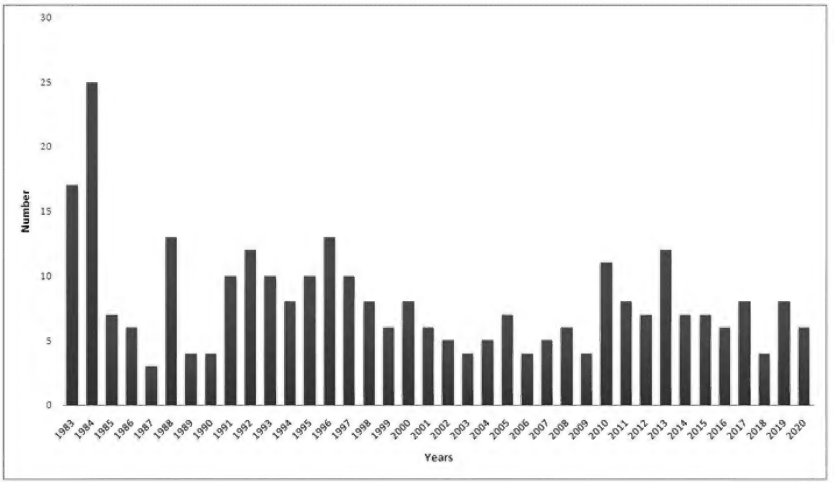


**Figure 5**. Highest annual counts of Grey Plover at Woodman Point 1983–2020.

black colouring around the face and on the breast. This progressively fades though some colouring persists well into late November. Colour becomes visible again in late March with black smudges on the flanks. The main departure is from late March. In some years, a few Grey Plover remain at Woodman Point during the Australian winter months. The number of Grey Plover frequenting Woodman Point in the 1980s was higher than in the past 25 years, with up to a maximum of 25 birds recorded (Fig. 5).

**Pacific Golden Plover** *Pluvialis fulva*

The Pacific Golden Plover is seen at Woodman Point only in some years (1999, 2000, 2001, 2002, 2006, 2008, 2018 and 2020; Table 2). It arrives in small flocks of two to 13 birds and these sometimes remain for two to six weeks. It is present from November to April.

**Greater Sand Plover** *Charadrius leschenaultii*

The earliest the Greater Sand Plover arrives at Woodman Point is late August, although arrivals are more common during the second half of September; the last sightings are in March. The Greater Sand Plover is sighted most years (Table 2). They are usually found in company with Red-capped Plover and favour open sandy beach areas well above the hightide line. The Greater Sand Plover has been present at Woodman Point for shorter periods in recent years. From the 1990s through to 2004 several Greater Sand Plover stayed throughout the spring and summer months. As an example, Greater Sand Plover were present from September to December 1995; September 1996 to January 1997 and December 2004 to January 2005. Sightings from the past three years have been of short duration and involved solitary birds (Fig. 6).

**Whimbrel** *Numenius phaeopus*

Whimbrel sightings have been of individual birds in January, February, March, May, November and December. There were intermittent sightings in 2000, 2001, 2004, 2011, 2014, 2015, 2016,

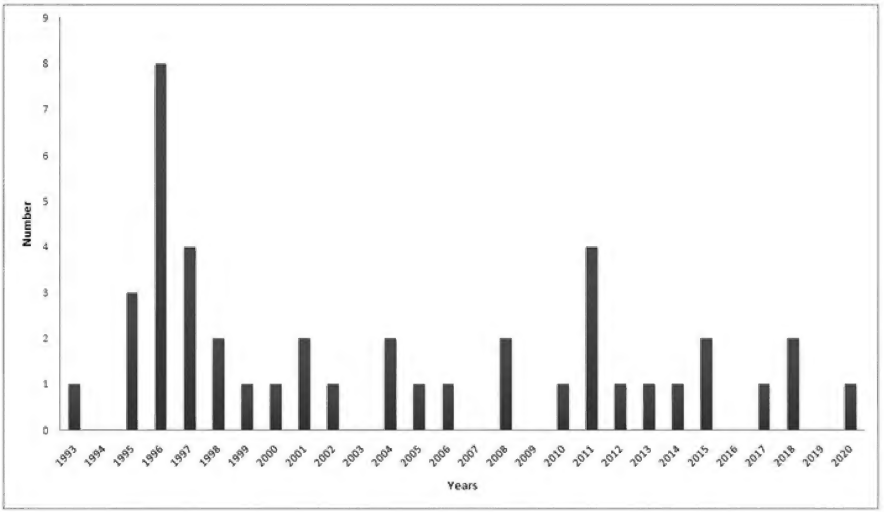


**Figure 6**. Highest annual counts of Greater Sand Plover at Woodman Point 1993–2020.

2017 and 2020 (Table 2). There have been more yearly sightings over the past decade. Whimbrel do not remain at Woodman Point for long and are likely to be in transit. There is one set of sightings from 7 February to 31 March 2015 which indicates at least one bird stayed for two months. There is an historical sighting of a Whimbrel on 11 November 1983.

**Eastern Curlew** *Numenius madagascariensis*

There are few sightings of Eastern Curlew at Woodman Point, even though there is suitable habitat available in the form of shallow waters, sandbanks with small molluscs and weed banks. Records are from February, March and December in 1997, 2002, 2012 and 2020 (Table 2). Sightings have been of solitary birds which may have been on their northward migration. Stopovers are of short duration; however, one remained for nearly three weeks in February 2020.

**Bar-tailed Godwit** *Limosa lapponica*

Bar-tailed Godwit are seen infrequently and in small numbers (one to two) and sometimes remain for a few weeks. Sightings are mainly in November and December, but the species is absent in some years. Birds have been sighted in January, February, March, May, June, November, and December. Recent records are from 2010, 2011, 2016 and 2020 (Table 2). The highest count was seven on 25 November 1995.

**Ruddy Turnstone** *Arenaria interpes*

Ruddy Turnstone have been present each year of the research period (Table 2). There have been observations of one to two birds during the winter months, although not in every year. Ruddy Turnstone arrive at Woodman Point from late August and numbers increase progressively, being most numerous from November to March. The Ruddy Turnstone population that remains at Woodman Point during the shorebird season is smaller than in the past although there are temporary increases

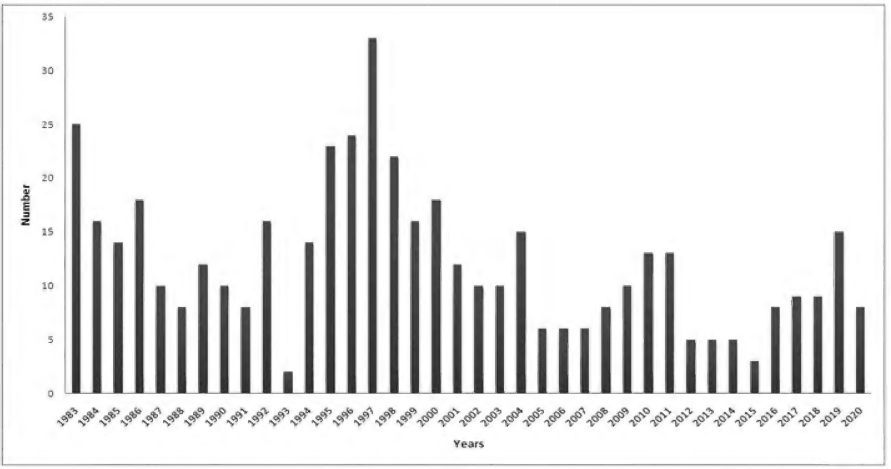


**Figure 7**. Highest annual counts of Ruddy Turnstone at Woodman Point 1983–2020.

in their numbers which may come from nearby sites such as Garden Island (Wykes 1999). Population fluctuations for the period 1983 to 2020, based on the highest annual count, are shown in Figure 7. Ruddy Turnstone feed on the banks of beach wrack and among the rocks in the tidal zone.

**Red Knot** *Calidris canutus*

Red Knot often occur in mixed flocks with Great Knot. Most sightings are of solitary birds and numbers rarely exceed five. They tend to remain at Woodman Point for several weeks. No Red Knot sightings have been made in June, July and August; most sightings are from April, May, October and November. The highest counts were 5 February 1984 (24 birds), October 1986 (22 birds) and 20 March 1998 (10 birds). A more recent sighting of seven Red Knot was made on 2 December 2020. No birds have been recorded in some years (Table 2).

**Great Knot** *Calidris tenuirostirs*

There used to be a distinct migratory pattern at Woodman Point, when small flocks of Great Knot arrived during April and May and stayed for around a month; for example, in April/May 1986 with a flock size of 65 to 87, in April/May 1996 with a flock size of 35 to 61, and in April/May 1997 with a flock size of 10 to 30 birds. This pattern ceased around 2000. A few Australian winter sightings of Great Knot were made on 3 July 1982 (30 birds), 30 June 1984 (45 birds), 6 July 1985 (23 birds), 2 June 1997 (one bird) and 15 June 1997 (six birds). The maximum number of Great Knot has not exceeded 11 birds in recent years. A few unseasonal Great Knot flocks were seen on 2 February 2008 (19 birds), 16 December 2010 (25 birds) and 29 January 2011 (27 birds). Fewer birds have been seen between 2000 to 2020 compared with 1980 to 1999 (Table 3). Sightings have been reported in every month of the year except for August. Fluctuations in the Great Knot population during the period 1986 to 2020 are shown in Figure 8 and are based on the highest annual counts.

**Sharp-tailed Sandpiper** *Calidris acuminata*

The Sharp-tailed Sandpiper is a rare visitor to Woodman Point (Table 2).

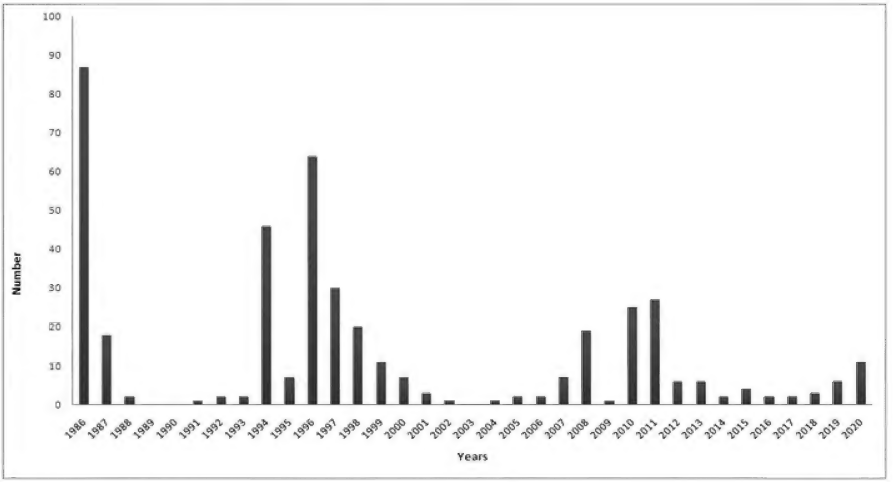


**Figure 8**. Highest annual counts of Great Knot at Woodman Point 1986–2020.

Three Sharp-tailed Sandpipers were seen on 3 July 1982, only six sightings have been made since 1995 with a maximum number of six birds reported. Sharp-tailed Sandpiper sightings are from March, July, September, October and December.

**Curlew Sandpiper** *Calidris ferruginea*

The Curlew Sandpiper is a rare visitor to Woodman Point (Table 2). Most records are of solitary birds seen in January, February, April, June, August, September, October and December. The Curlew Sandpiper has not been sighted at Woodman Point since 2012. There was a sighting of a small flock on 30 January 2000 when 59 Curlew Sandpiper were seen. There are two older records of Curlew Sandpiper sightings from 16 September 1983 (one bird) and in December 1991 (five birds).

**Red-necked Stint** *Calidris ruficollis*

Red-necked Stint have maintained a steady presence at Woodman Point for 25 years (Table 2). Numbers have always been relatively low. In the 1980s and 1990s a maximum of 27 Red-necked Stint were recorded, however, since 2004 numbers have not exceeded 10 (Table 3). A few observations were made of solitary stints during the Australian winter months in August 1995 and June 1996. Over the past 10 years numbers and sightings have declined.

**Sanderling** *Calidris alba*

Woodman Point used to be the only mainland site near Perth where Sanderling could always be seen during the shorebird season. The other sites were insular, on Rottnest and Garden Islands (Singor 2006). However, in the late 1990s numbers rapidly declined (Tables 2, 3). Since then only sporadic sightings have been made, birds have not been seen every year and visits are of short duration. Maximum counts are: 60 in December 1983, 54 in November 1986 and 27 in November 1995. Sanderling have been largely absent since 2001. Sanderling population fluctuations for the period 1986 to 2020, based on the

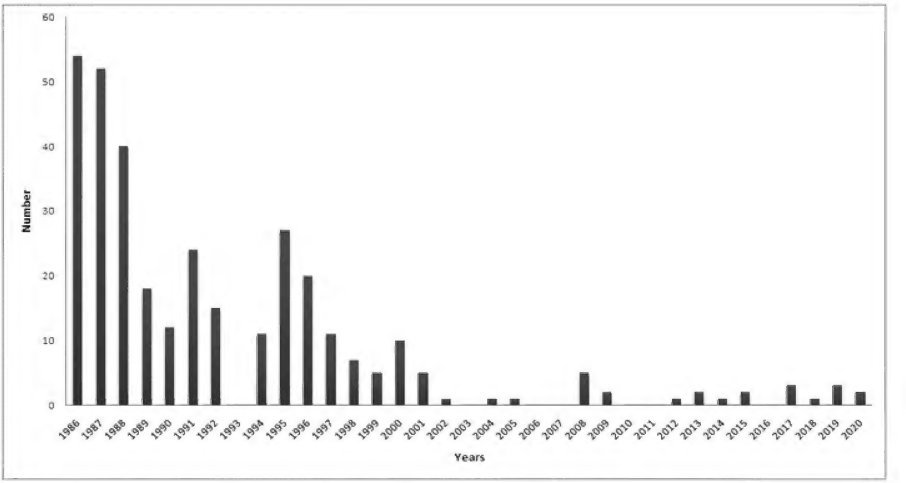


**Figure 9**. Highest annual counts of Sanderling at Woodman Point 1986–2020.

highest annual count, are shown in Figure 9. Their preference for sandy ocean beaches makes them especially susceptible to disturbances.

**Terek Sandpiper** *Xenus cinereus*

The Terek Sandpiper is a rare visitor to Woodman Point. There were sightings in 1983, 1984 and 1985 which were of single birds, apart from two being reported in December 1983 (Table 3). Sightings are from February, March, May, September, October, November and December. Recently Terek Sandpiper have been observed in 1995, 1997, 2000, 2009, 2016, 2019 and 2020 (Table 2).

**Common Sandpiper** *Actitis hypoleucos*

Common Sandpiper favour the rocky coastal habitat along the groynes and shoreline. Most sightings are from August to April and in June, with no sightings in May and July. Sightings are of solitary, rarely two birds (Table 3). In recent years sightings of the Common Sandpiper have become less frequent (Table 2).

**Grey-tailed Tattler** *Heteroscelis brevipes*

This is one of the few wader species, that in the 1990s maintained almost a year-round presence at Woodman Point. Since then the Grey-tailed Tattler has become a more seasonal migrant. The species is usually solitary, although there have been a few observations of two to three birds, with one sighting of four on 9 March 2003. The Grey-tailed Tattler was present each year until 2004; since then it has not been seen every year (Table 2). It remains at Woodman Point for extended periods and frequents the weed banks and rocky shorelines along Woodman Spit.

**Common Greenshank** *Tringa nebularia*

The Common Greenshank is an irregular visitor to Woodman Point. It is generally solitary, although there are records of up to five birds (Table 2). Common Greenshank feed in shallow pools of seawater among seagrass beds at low tide and at the end of Woodman Spit. Sightings have been from January to May and from September to December, but they were absent during the Australian winter months.

## Australian breeding shorebirds

### Australian Pied Oystercatcher *Haematopus longirostris*

Woodman Point attracted large numbers of Australian Pied Oystercatcher in the early 1980s, when it was not unusual to see 30 to 40 birds. The highest count of 53 is from May and June 1984. Since 1998 there have been no counts greater than 10 birds, and numbers in recent years are generally between one and four. Australian Pied Oystercatcher have been seen each year during the research period (Table 2). They often use a sandbank rich in cockles north of the Woodman Spit as a feeding site at low tides. Also, winter storms wash up large numbers of cockles and other bivalves onto the sandy areas of the Woodman Spit, providing a rich feeding ground. Australian Pied Oystercatcher nests mainly on sandy beaches or among sand dunes. They have not been recorded as breeding at Woodman Point.

### Sooty Oystercatcher *Haematopus fuliginosus*

The Sooty Oystercatcher is an irregular visitor which can be absent for years (Table 2). It has been observed in every month apart from January and November, with most sightings between May and September. There were two sightings of two Sooty Oystercatcher in 1987 and one sighting of four birds in July 1982; since 1987 all sightings have been of solitary birds. The Sooty Oystercatcher may originate from nearby offshore islands such as Carnac Island, Rottnest Island and Garden Island.

### Banded Stilt *Cladorhynchus leucocephalus*

Banded Stilt are seen occasionally at Woodman Point, but not every year (Table 2). A small flock of 15 birds was seen on 9 February 1984 and the species was present in January 1986 and 1989. Birds have been observed in January, February, March, May, June and December. Most sightings are in January and numbers do not exceed 10 birds.

### Red-necked Avocet *Recurvirostra novahollandiae*

Red-necked Avocet have been seen sporadically at Woodman Point (Table 2). Records for the period 1983 to 1994 show two flocks were present in February 1983 (16 birds) and February 1984 (24 birds); there was a single sighting in March 1991. More recently small flocks have been sighted in February, March, April, July and December. Most sightings are in March and December, with flocks of fewer than 10 birds.

### Pied Stilt *Himantopus himantopus*

Pied Stilt are seen at Woodman Point at irregular intervals (Table 2). A small flock of 15 was seen resting at Owen Anchorage beach on 3 February 1996, however, sightings are generally of one to two birds. They have been seen in January, February, March, April, June, October, November and December. Pied Stilts are probably opportunistic visitors seeking new feeding grounds as the lakes on the Swan Coastal Plain dry out. Alternatively, their presence could be part of seasonal movements (Minton *et al*. 2017).

**Red-capped Plover** *Charadrius ruficapillus*

This is one of Woodman Point's residential shorebirds (Table 2). The highest count was 49 birds on 13 February 1998, highest counts have been in the summer months of December, January and February. Over the past decade the number of Red-capped Plover has generally been below 12 birds. Red-capped Plover are often seen in loose groups roosting high up on the beach above the high-water line where Sea Rocket (*Cakile maritima*) grows. Breeding was confirmed on 23 December 2007 when a pair of Red-capped Plover and one runner were sighted. This is the only confirmed breeding record for an Australian breeding shorebird species during the research period.

### Occasional visitors

Another six shorebird species have been seen occasionally at Woodman Point. These are of a few sightings of Lesser Sand Plover, *Charadrius mongolus* and Hooded Plover, *Thinornis cucullatus*, and single sightings of Broad-billed Sandpiper, *Limicola falcinellus* (12 December 1983), Little Curlew, *Numenius minutus* (20 October 1996) (Neville & Downes 1996), Asian Dowitcher, *Limnodromus semipalmatus* (25 November 1995) (Sandilands 1996) and Red-kneed Dotterel, *Erythrogonys cinctus* (9 January 1984).

### Leg flagged birds

No leg flagged shorebirds have been seen at Woodman Point.

## Discussion

The commentary provided and conclusions drawn are based entirely on the observations made by the author and need to be viewed in that context.

Due its size, Woodman Point lends itself to consistent and repeatable monitoring of both migratory and Australian breeding shorebirds. Long term data collected, even from a small shorebird site like this, are important as they reflect the wider trends in the EAAF and contribute towards flyway population estimates (Hansen *et al.* 2016).

The peak shorebird season at Woodman Point is from October to March (Table 4). A comparison of the abundance of shorebirds during the

**Table 4**. Comparison of the average number of individual shorebirds sighted at Woodman Point during the period 1995–2020.

| Period | Number of surveys | Mean number of all shorebirds on site | Migratory shorebirds | Australian breeding shorebirds |
|---|---|---|---|---|
| Oct. 1995 to March 1996 | 19 | 57 | 43 | 14 |
| Oct 1997 to March 1998 | 17 | 56 | 35 | 21 |
| Oct. 1998 to March 1999 | 11 | 44 | 2 | 22 |
| Nov. 2004 to March 2005 | 17 | 29 | 13 | 16 |
| Oct. 2014 to March 2015 | 13 | 9 | 6 | 3 |
| Oct. 2018 to March 2019 | 16 | 8 | 7 | 1 |
| Oct. 2019 to March 2020 | 49 | 9 | 8 | 1 |

survey period shows that an average of 57 shorebirds would have been observed on a visit to Woodman Point during the period October 1995 to March 1996; however, this number has declined to nine shorebirds for a visit during October 2019 to March 2020 (Table 4). Between 1995 and 2020 the shorebird population has declined by 84%.

The migratory shorebird population at Woodman Point has shown a steady decline over the past 25 year period. The Australian breeding shorebird population has shown a steep decline particularly over the past five years (Table 4); this is most likely to be the result of the increased number of beachgoers. (Colmar Brunton 2001, 2005).

The number of shorebird species sighted at Woodman Point from May 1995 until May 2020 has reduced marginally over the research period. An average number of 12 species was recorded annually during 1995 to 2020. There are several shorebird species that have maintained their presence over the past 25 years, though in lesser numbers. These are Grey Plover, Ruddy Turnstone, Red-necked Stint, Australian Pied Oystercatcher and Red-capped Plover. There has been a slight decline in the number of migratory species seen at Woodman Point (Table 2). When interpreting this incidence data, however, it is important to recognise it can be of a solitary sighting or of multiple sightings for that year.

The most noticeable changes have been the duration of shorebirds' stopovers at Woodman Point and their number (Tables 2,3). In the past, a flock of shorebirds would remain on site for weeks or months. In recent years this has been more likely to be only a few days.

The size of flocks has reduced considerably, with the Australian Pied Oystercatcher, Great Knot and Sanderling as examples (Figs. 8, 9). Woodman Point supported a flock of Sanderling until about 2000 after which this shorebird largely disappeared (Table 3). The Greater Sand Plover maintained an ongoing presence over the Australian summer season at Woodman Point until about January 2005 and is now only an occasional short-term visitor (Fig. 6).

The beaches at Woodman Point are narrow and with a shallow gradient (Fig. 4) so any disturbance is concentrated in a small area. These beaches provide a habitat that is favoured by specialist beach feeding shorebirds such as Sanderling and Australian Pied Oystercatchers. Long term disturbance will profoundly affect these specialists, as is evident in the population trends for Sanderling (Fig. 9).

Disturbance levels are likely to have contributed to the reduction in length of the stopover of migratory shorebirds. In the 1990s four-wheel drive vehicles had ready access to the beach, groyne and dunes and caused considerable damage to the vegetation and disturbance to shorebirds. The installation of limestone barriers in September 1996 and additional reinforcements in April 1998 prevented these intrusions. The over-harvesting of the cockleshell beds to the north of the groyne impacted on an Oystercatcher feeding area. Redevelopment and sealing of the access road and parking areas occurred in 2002 and resulted in increased visitor numbers. A visitor survey undertaken in 2005 indicated

that visits to the Woodman Point headland had increased substantially from 2001 levels, which likely reflect the improvements to visitor facilities in this area, the use of the area for fishing and access to the coast for wind and kite surfing (Colmar Brunton 2001, 2005). Fishing is the dominant recreational activity in this part of the park (Colmar Brunton 2001, 2005).

Future developments in Cockburn Sound may also impact shorebird populations. For example, the proposal to locate a new container port in Cockburn Sound will involve dredging and increased shipping. This has the potential to impact environmental conditions at Woodman Point, including shorebird populations and seagrass meadows (Department of Transport 2020).

The conservation responsibilities for the Woodman Point Reserve are contained in the Woodman Point Regional Park Management Plan (2010). The locations used by the shorebirds fall within Reserve 49220 which is classified as a conservation and protection management zone. The management plan objectives are to enhance the conservation values and restore the natural vegetation of the reserve, to maintain the natural state of the reserve and implement measures to mitigate environmental impacts. The management plan excludes dogs from the conservation areas although this is not enforced, as dogs (often unrestrained) are a common sight in the conservation area. There is limited signage in place informing the public of conservation measures.

Local factors contributing to the decline of shorebirds at Woodman Point seem attributable to increasing visitor numbers, dogs, kite surfing and the lack of enforcement of the Management Plan directives. Improved management of the conservation areas at Woodman Point Headland is needed to benefit shorebird populations and provide an opportunity for the Fairy Tern (*Sternula nereis*) which is listed as Vulnerable under the WA Biodiversity Conservation Act and federal EPBC Act, and Red-capped Plover, to breed within the reserve as they have in the past.

The decline in migratory shorebirds is consistent with findings from other studies conducted at Pelican Point, Alfred Cove and Rottnest Island (Creed & Bailey 1998; Singor 2009; Mather 2020). The reduced numbers of Australian breeding shorebirds at Woodman Point is attributed to local factors such as recreational pressures.

The Cockburn Council adopted the City's Animal Management and Exercise Plan 2020-2025 on 10 September 2020. This plan stipulates that Woodman Point will be a dog prohibited area, and is an encouraging development.

## Acknowledgements

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# A new weed alert for the north-west of Australia: Mopane (*Colophospermum mopane*)

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**Abstract**

*Colophospermum mopane,* a widespread African legume has become established in the southern Kimberley region of Western Australia. Mopane is climatically ideally suited to the summer rainfall areas of northern Australia. The species could be a very significant weed of the Fitzroy River alluvial soils.

## Introduction

*Colophospermum mopane* (J. Kirk. ex Benth.) J. Leonard, commonly called Mopa, Mopane, Mopani, Balsam Tree, Butterfly Tree-or Turpentine Tree, is a wind pollinated tree in the Legume family (Fabaceae, subfamily Caesalpinoideae). There is only one species in the genus and this is an economically and ecologically important tree (Timberlake 1999) that dominates the savanna woodlands of south-central Africa (southern Angola, northern Namibia, northern Botswana, Zimbabwe, southern Zambia, southern Malawi, northern South Africa and Mozambique).

Mopane is reputed to provide the best fuelwood in Africa (Mokhado *et al.* 2000). Mopane grows in summer rainfall areas on hot dry low-lying areas with no frost. Mopane occurs on calcareous and alluvial soils and sheds it leaves during the dry season. The species grows gregariously, meaning that many individuals grow together to the near or total exclusion of other plant species (Brummitt *et al.* 2007). Extensive coppicing after fires can result in dense impenetrable thickets. The species produces copious amounts of wind and water dispersed seeds (Styles & Skinner 1997) which produce dense even aged stands in alluvial and sandy sites, which flower after five years.

This brief note follows an unpublished review of this species for the Western Australian Herbarium in 2017, and is intended to document and record the weed potential of this species for a wider audience.

## Weed status

Mopane has been widely planted in arid regions of India for agroforestry and rehabilitation, and there is conflicting information on naturalisation. The USDA website (USDA 2013) in ranks Mopane as

"low risk" and states there is no evidence of this species naturalizing in India. However, in local publications there is some evidence that local spread outside of plantings is occurring (Bhandari 1990), but this has not been widely documented. Randall (2001) notes that the species is a local increaser agricultural weed in its native Africa, but there are few records elsewhere. Increased densities in Africa are due to the widespread loss of elephant grazing, for which the tree is a favoured food (Smit 2001).

Mopane has been recorded by one of the authors (AAM) from a naturalizing population at Quanbun Downs station in the southern Kimberley in 2004. Here the species was actively spreading from a fence-line planting into the adjacent black soil plains. After advice from Keighery (2017), the species was added to the list of naturalized plants of Western Australia in 2017 (Western Australian Herbarium, 1998–) and is currently a prohibited import to Western Australia.

## Conclusions

Although across the world there are few records of Mopane acting as a weed, the species is climatically ideally suited to the summer rainfall areas of northern Australia. Aspects of the biology of Mopane are also of concern as to its weed potential in Australia. The species is fast growing, able to survive fires and able to form dense monospecific stands in its native habitat. Plants are wind pollinated and the copious seeds produced are wind and water dispersed. There are no native herbivores which would keep this species in check in Western Australia. The species could be a very significant weed of the Fitzroy River alluvial soils (and elsewhere in the Kimberley) if not removed. We strongly recommend that this species be listed as an alert weed at the national level to prevent it becoming established in Australia.

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# Obituary

## Barbara York Main OAM
## 27 January 1929–14 May 2019

Adjunct Professor Barbara York Main was a devout scientist who cared deeply about the unique Australian landscape. Her passion for the south-west of Australia, and especially the wheatbelt, was evident throughout her nature writing. This is exemplified in *Between Wodjil and Tor* (Main (1967) Jacaranda Press: Brisbane; Landfall Press: Perth), a book that demonstrates a deep connection and appreciation for the environment near her family farm in the wheatbelt near Tammin; an area where she also conducted her famous long-term study that recorded the world's oldest spider that died at 43 years old. Even as a child Barbara loved exploring, and the insects intrigued her. Although she also appreciated other local species (many of which have since gone locally extinct), they did not excite her in the same way. She said "It was a matter of scale. I could relate to insects in a way that I couldn't with birds or reptiles." And as it was not anticipated that Barbara would inherit the farm like her brothers or to help manage a farm unless she married a farmer, she decided early as a young country girl to become an entomologist. And she did just that.

Barbara was a member of the remarkable generation of women who cracked the glass ceiling in scientific academia. Until the mid-20th century women were denied access to formal scientific education and refused membership in professional societies. Barbara wrote about conservation issues such as land clearing, climate change and invertebrate extinctions decades before these topics became mainstream. A truly remarkable feat for an Australian woman born in 1929, who never had a permanent job with salary or significant research funding, and the first female to complete a PhD in Zoology at University of Western Australia. Without the progressive mindset and support of her husband Bert (they married in 1953) — a celebrated conservation scientist in his own right — it is unlikely that Barbara

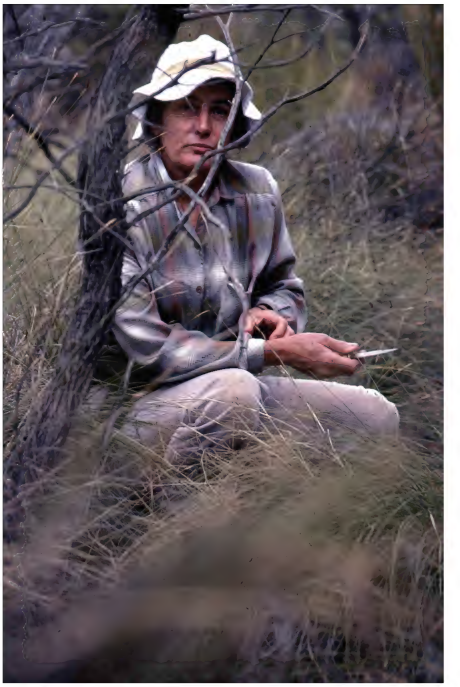

**Figure 1**. Barbara in 1980 at North Bungulla surveying her long-term trapdoor spider study site. Photo: Ron York (Barbara's brother).

would have been as successful in her quiet undermining of the patriarchy.

Notwithstanding the serious limitations of the times, Barbara wrote four books and over 90 book chapters and scientific papers. She is recognized for her prolific work in the natural history, biogeography and taxonomy of mygalomorph spiders. The BBC and ABC produced a film about her work, 'Lady of the Spiders' in 1981 (narrated by Sir David Attenborough). She was awarded the Medal of the Order of Australia in 2011 for her contributions to the field of arachnology and in 2018 she became the first woman to receive the Medal of the Royal Society of Western Australia.

From 1999, Barbara was co-patron of the WA Naturalists' Club, first with her husband Bert Main, and later with Lyn Beazley. Barbara was an Honorary Life Member of the WA Naturalists' Club with Bert, along with Harry Butler, Dom Serventy, Rica Erickson, John Dell and many other prominent Club members.

Barbara published many articles in the Club's journal:

**Main, B.Y.** (1952). Notes on the genus *Idiosoma*, a supposedly rare Western Australian Trap-Door Spider. *Western Australian Naturalist* **3:** 130–137.

**Main, B.Y.** (1956). Observations on the burrow and natural history of the trap-door spider *Missulena* (Ctenizidae). *Western Australian Naturalist* **5:** 73–80.

**Main, B.Y.** & Main, A.R. (1956). Spider predator on a vertebrate. *Western Australian Naturalist* **5**: 139.

**Figure 2**. A female *Gaius villosus*. Barbara's work showed this is the longest lived species of spider recorded. Photo: Leanda Mason.

**Main, B.Y.** (1957). Occurrence of the trap-door spider *Conothele malayana* (Doleschall) in Australia [Mygalomorphae: Ctenizidae]. *Western Australian Naturalist* **5**: 209–216.

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**Figure 3**. Bert and Barbara in 1955. Photo provided by Monica Main. Photographer unknown.

**Friends and colleagues' recollections of Barbara York Main**

Lyn Beazley, Western Australian Naturalists' Club patron:

> "I was thrilled and honoured to work beside Barbara at the University of Western Australia. More recently I joined Barbara as co-patron of the WA Naturalist Club and was delighted when Barbara became the first women to be awarded the Medal of the WA Royal Society, a well-deserved honour. Barbara's love of nature and unceasing wonder at the creatures, especially spiders, in her beloved WA bush inspired us all. Bearing her formidable international reputation lightly, Barbara always glowed with *joie-de-vie*, warmth, grace and good humour, staying young at heart through her life. Thank you, Barbara, for being very special."

Yvonne Doncaster (formerly Paterson), worked with Barbara:

"My connection with Bert and Barbara Main began in 1976 when I was transferred from University of Western Australia's Reid Library to manage the small Zoology Department library "up the hill" beside St George's College. This was housed in the first purpose-built brick building for the relocated University (from Pier St, Perth) to house the Biology Department's staff in laboratories, offices, and a library from 1924 onwards.

Barbara's unofficial 'pad' was on the floor above the library, sharing Bert's rooms from the early 1960s until she was given Honorary status as a Lecturer in 1979, with her own space at last. I would often pop in for a chat when delivering book requests nearby, and watched the spider tubs on the verandah outside her room with interest, but mostly giving them a wide berth! They were 'part of the furniture' on that verandah for all the years I worked up there, 1976–1990.

Don Bradshaw was Head of Department (CEO) during this time and ex-officio Prof. Harry Waring still firmly settled into his large, madly overstuffed room – books, boxes and booze welcoming his many visitors until his death in 1980.

I enjoyed my work in charge of the library for 14 years, saw many students come and go in that time, but the staff were long-term and I made many friends and mentors here, most particularly Bert and Barb.

When I took early retirement in 1990, due to my husband Grant's ill health, I soon began another long connection with a scientific institution, the Western Australian Museum, where I was a volunteer in their library for over 20 years. I still kept in touch with Barbara, who was a Museum Trustee as well as an honorary Entomology Department researcher, bumping into her either at morning tea or when visiting Entomology on library business.

Finally, being invited to join the W.A. Naturalists' Club by John Dell in the early 1990s, we quickly became cognisant of the input that Bert and Barb had had with this group over many years. Opening their Torbay property (down on the south coast where they grew avocados!) to members over some Easter weekends, I was able to experience first-hand their amazing connection to the land in 2002.

A good life, well lived, beloved by family, friends and workmates here in W.A., but also on the international scene for her wonderful contributions to spider ecology & biogeography – Vale, Barbara."

Mick Davis who now leads the WA Landcare Network, worked previously for Wheatbelt NRM as their Biodiversity Program Manager and Regional Landcare Facilitator, where he met and consulted with Barbara about trapdoor spiders:

"When I was just dipping my toes into mygals, I asked to meet Barbara at UWA to talk about my two fav[ourite] species, *A[ganippe] castellum* and *I[diosoma] nigrum*.

Barbara was so accommodating to some random guy from out in the wheatbelt. She invited me into her lab, casually noted [the trapdoor spider in a planter pot] next to her desk, then began to show me her compactus (usually reserves

for books), full of jars within jars of preserved spiders. I was so astounded.

I recall she mentioned there was another life's work there, to go through and do the taxonomy on them all!

The other thing that I remember from that day, like it was just yesterday, was her bright, curious eyes, as she asked me questions about my interests. And the way she placed her glasses askew on her face as we spoke – I've always thought this might have been so they were always close, while looking into a microscope to identify a specimen from one of the many folk who sent her specimens..."

Dr Leanda Mason met Barbara in 2008 at the University of Western Australia during her undergraduate studies. Barbara was a well-loved mentor, colleague and friend for the following 11 years. Leanda wrote a poem for Barbara, published in 'Tribute to Dr Barbara York Main OAM: arachnologist and nature writer (27 January 1929–2019)', by *Pacific Conservation Biology*. It is reproduced here with permission.

**Owed to Barbara**

Over time and career we learn and we teach
Share knowledge and wisdom with those we can reach
From formal instruction in methods and fact
To personal doctrines that shape how we act

Sometimes we're lucky and we will be blessed
With a capable mentor who inspires our best
Respected and learned in their field or skill
We follow direction, a vessel to fill

Barbara York Main was a lady I followed
Down paths she has cleared, into niches she's hollowed
In hindsight it's taken me years just to process
The foresight that Barbara invoked toward progress

A woman of science, a pioneer true
Earned on her own merit and helped herself through
Hostile environments inside and out,
Endured for pure research, not standing or clout

Though humble, reclusive and hidden from sight
Her books and her papers would shed quite a light
On my personal interest to study her spider
I soon had a goal and sat down beside her

Her patience, wisdom, and determined resilience
Ethics and values of unquestioned brilliance
Seeds that she felt were the right ones to sow
Indeed sprouted roots and continued to grow

The great minds among us see forward and back
Through time and tradition to pick up the slack

Understanding the past for exploring the new
Reliable structures that extrapolate through

Contributions of insight, experiments that start
Without any kudos or gain from this part
Longitudinal work in its slow onward grindings
Bestow on the next generation deep findings

And then there's the story of #16
The oldest of spiders the world had yet seen
A trapdoor whom Barbara discovered and tagged
Went virally famous when dead it was flagged

Though honoured to speak on behalf of the study
It pains me that Barbara's thoughts then got muddy
Too late moments of praise, recognition of worth,
Efforts and great contributions to earth

So much achieved, so much more to contribute
A lifetime of lessons passed on to distribute
Through publishing, teaching or close demonstration
Humanity learns only from collaboration

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**From Field and Study**

# Germination by some fire ephemeral plant species on the Darling Scarp, Gooseberry Hill, following a period of low rainfall and high summer temperature

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During spring 2011, I was surprised to find patches of the fire ephemeral species *Actinotus leucocephalus* and *Trachymene coerulea* growing on parts of my Gooseberry Hill study area that had remained unburnt since March 2007 (Fig. 1) (see Brooker 2001 for a description of the study area). The previous year (2010) had received the second lowest annual rainfall recorded in 70 years at Perth Airport (482 mm) and the lowest in 46 years in records made on Gooseberry Hill (453 mm). The months from late spring 2010 to early autumn 2011 were hot with average maximum temperatures at Perth Airport above average for all months except December and the

**Figure 1.** *Actinotus leucocephalus* and *Trachymene coerulea* flowering on north-western section of the study area, 2 December 2011. Photo: Michael Brooker.

**Figure 2.** Vegetation showing diallagy in April 2011. The West Zig Transect (WZ) sites are at the top right of the scene. Photo: Michael Brooker.

highest ever recorded for November (30.3°C) and March (32.8°C). The extensive degree of diallagy (George 2002a) in the vegetation of this area in the following autumn (2011) is shown in Figure 2.

In order to properly document these findings, I re-censused some plant sites in December 2011 on two Darling Range transects that I had previously monitored from April 1990 to December 2008 through four wildfires. These sites had been established on areas burnt in January 1990. A tape measure was used to mark the centre of sites 5 m apart and these points were visited monthly to record species flowering within 1 m of the ribboned point. Forty-five of the sites were located on a west-facing part of the scarp, 220 m and 50° from 31°56'23"E, 116°02'45"S (Scarp Transect (SCP)) and 41 were on east-facing sites 100 m north and 100 m west from 31°56'13"E, 116°03'01"S (West Zig Transect (WZ)).

The December 2011 census revealed the presence of three species of fire ephemerals *Austrostipa* sp., *Actinotus leucocephalus* and *Trachymene coerulea* (Table 1). The identification of the species of *Austrostipa* was not checked at the time, although two fire ephemeral species, *A. compressa* and *A. macalpinei,* do occur here (Western Australian Herbarium 1998 – *FloraBase*, Brooker & Hussey 2001), and detailed comparisons with respect to seed dormancy and germination by these

**Table 1.** Presence during October to December of *Austrostipa* sp. (STIPA), *Actinotus leucocephalus* (ALEU) and *Trachymene coerulea* (TCOE) on 45 Scarp Transect sites (SCP) and 41 West Zig Transect sites (WZ) at Gooseberry Hill, following four fires which burnt all sites except during the 6 February 1994 fire, when only 16 were burnt at SCP and 35 at WZ.

| Fire | Year | STIPA | | ALEU | | TCOE | |
|---|---|---|---|---|---|---|---|
| | | SCP | WZ | SCP | WZ | SCP | WZ |
| 3 Jan | 1990 | 8 | 8 | 14 | 13 | 3 | 1 |
| | 1991 | 1 | | 1 | 4 | | 1 |
| | 1992 | | | 1 | | | |
| | 1993 | | | | | | |
| 6 Feb | 1994 | 6 | 8 | 6 | 11 | | 1 |
| | 1995 | | | 7 | 5 | | |
| | 1996 | | | 1 | 1 | | |
| | 1997 | | | | 1 | | |
| | 1998 | | | 1 | 2 | | 1 |
| | 1999 | | | | 1 | | |
| | 2000 | | | | | | |
| 20 Dec | 2001 | 23 | 10 | 14 | 12 | 2 | 3 |
| | 2002 | | | | | | |
| | 2003 | | | | | | |
| | 2004 | | | 5 | 5 | | |
| | 2005 | | | 3 | 4 | | |
| | 2006 | | | | | | |
| 8 Mar | 2007 | 40 | 11 | 20 | 13 | 5 | 5 |
| | 2008 | 9 | 3 | 5 | 4 | | |
| | 2011 | 17 | 2 | 19 | 11 | 4 | 4 |

two species (Baker *et al*. 2005) found mostly similar responses. Table 1 shows that *Austrostipa* responded as expected for this fire ephemeral (Smith *et al*. 1999) after the first three fires, with only one record in a non-fire year. However, after the fourth fire of 2007, it germinated on 14% of the 86 sites in 2008, the second season after the burn. The preceding climatic conditions to spring 2008 were neither abnormally dry nor hot. A possible explanation could be that the response two winters post-fire was due to a carry-over effect from that late-in-season, hot wildfire. Of the seven major Gooseberry Hill fires observed by the author, the March 2007 burn was the only one that caused extensive exfoliation of some granite rocks. It was also the only one that killed a number of mature Wandoo (*Eucalyptus wandoo*) and Marri (*Corymbia calophylla*) outright and many of those that did survive resprouted only from their bases.

*Trachymene coerulea* behaved as a fire ephemeral (Table 1) although this species was relatively rare here probably because it does not favour the lateritic and doleritic soils (Brooker & Hussey 2001) found on much of the SCP and WZ transects. It was

widespread elsewhere on the study area occurring following fire (e.g. on 44% of 1106 sites following the 1994 fire; Brooker & Hussey 2001) and in the spring of 2011 following the hot dry preceding summer (Fig. 1).

While the third fire ephemeral *Actinotus leucocephalus* was most common in the first post-fire season, it was found also on the transects in 10 of the 14 non-fire years (71%).

A replication of the 2010–2011 climatic conditions occurred during the course of my observations, both here and elsewhere in the south west of the state during the summer and autumn of 2000–2001 (George 2002b) but the December 2000 fire on the Gooseberry Hill area precluded any comparison with my 2010–2011 observations.

These observations suggest that some fire ephemeral plant species from three different families can also germinate following a prolonged period of low rainfall in the absence of fire. This ability could be of some interest given the climate change predictions for precipitation in south-western Western Australia (Bates *et al.* 2008) and their impacts on its flora (Yates *et al.* 2010).

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**From Field and Study**

# An observation of ants harvesting a fruit body of *Amanita*

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This article reports a recent observation of ants harvesting fungi in the Perth region, Western Australia. The observation is quite rare and unexpected because ants are not generally considered as mycophagists (fungus-feeders), aside from some exceptions, e.g. some attine ants cultivate fungi in their nests. The observation is also surprising because it involves *Amanita* — a genus of fungi which includes some species with lethal cyclopeptide toxins.

Date and location of observation: 5 July 2020. Fred Jacoby Park, Mundaring, Western Australia, near the sign-posted entrance of a walking track into the Beelu National Park (31°56'49"S 116°10'29"E).

Numerous large ants were observed crawling upon and around a white fruit body of a fungus that was evidently immature as it had only partially emerged from the soil (Fig. 1). The ants were identified later as common meat ants *Iridomyrmex purpureus* by Brian Heterick (pers. comm.). On closer inspection it could be seen that the ants were using their pincer-like mandibles to carve off small chunks of flesh and gills from the already partly demolished fruit body (Fig. 2). Individual ants were observed grasping an extracted piece of tissue with their mandibles and carrying the piece to their nest entrances about 1 m away (Fig. 3).

Initially the identity of the fungus *in situ* could not be confidently determined as its lower part was not visible above the soil. After observing the ants for about one hour, I uprooted the fruit body in order to try and identify it (Fig. 4). The base of the fruit body was revealed to be cup-like (volvate) — a feature in combination with the overall shape, colour and texture of the fruit body that is typical of many species in the genus *Amanita*.

Not surprisingly, the action of uprooting the fruit body immediately triggered the ants to scatter in a frenzied manner from attending their harvesting activities. Remarkably, within a few minutes after the uprooted fruit body was replaced on its side over the original position of emergence, many of the agitated ants clambered back onto the fruit body and resumed harvesting.

The re-colonised fruit body was left remaining on its side to allow the ants to continue their harvesting to completion. Hence no samples were taken from it for detailed identification analyses, or for detection of toxins. Nevertheless some clues for narrowing down its possible identity within the genus *Amanita* are evident from the particular type of volvate base on the

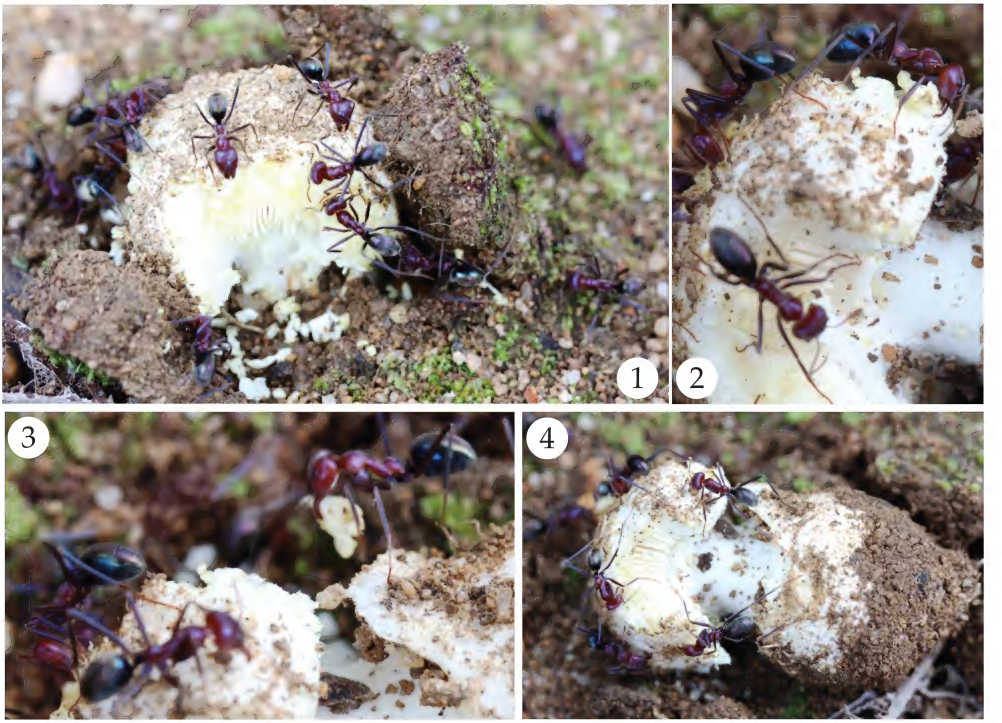


**Figure 1.** Fruit body of *Amanita* sp. *in situ* partially emerged from moss-covered soil, and attended to by harvesting ants. Some of the fungal tissue excavated by the ants is strewn on the soil around the fruit body.

**Figure 2.** Three ants in the process of excavating cap and gill tissue with the use of their mandibles.

**Figure 3.** An ant has just finished excavating a piece of fungal tissue from the fruit body and has picked it up with its mandibles in readiness to carry it away to the ant nest.

**Figure 4.** The fruit body of *Amanita* sp. uprooted and laid on its side, showing the partially excavated cap with some exposed gills, the cup-like base (volva), and resumption of harvesting activities by the ants after the disturbance.

All photos: Neale Bougher.

fruit body, i.e. one with a free volval limb (a membranous rim).

The observation as described here poses some interesting questions, such as about the possible benefits and degree of dependence involved in the relationship between the *Iridomyrmex purpureus* ants and the *Amanita* fungus. Many types of animals ranging from invertebrates to mammals feed on fungi, in relationships that are often mutually beneficial to both participants — the animal gains nutrition, and the fungus spores are dispersed by the animal. In the currently observed case the *Iridomyrmex purpureus* ants may have gained nutritional benefit from consuming the fungus, but it is unlikely that the *Amanita* fungus would have gained any benefit from

being consumed because the fruit body was probably too immature to have any viable spores. More generally, it seems unlikely that fungi would form a significant or consistent part of the diet of *Iridomyrmex purpureus* ants. In the case reported here the *Amanita* fruit body was emerging in the pathway of a busy ant track, and therefore was virtually unavoidable by the ants. The current observations suggest that these ants are not merely accidental mycophagists which may only ingest fungi incidentally in the course of seeking and eating other foods. Rather, the observed ants displayed determined systematic harvest and transport of fungi to their nest. Such behaviour suggests that these ants should be considered to be casual or opportunistic mycophagists, occasionally feeding on fungi in some situations — such as when confronted with a fruit body in the pathway of their track.

**From Field and Study**

# *Lycopus europeus* L. (Lamiaceae), a new weed record for Australia

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*Lycopus* (Lamiaceae) is a genus of 21 species of herbaceous perennials mostly found in wetlands and damplands. The genus is mainly found in the northern hemisphere with the greatest concentration of species in North America (10) and eastern Asia (8).

In March 2018 Geraldine Janicke posted a series of photos on the Weeds of Western Australia Facebook page that were obviously a *Lycopus*, a genus not previously recorded in Western Australia. The plants were found to be well established around a wetland along Princess Royal Harbour (Albany), spreading both from seed and stolons. Material from this population was cultivated to verify the identity of the weed.

The collection, while obviously an introduction, posed some identification issues as it could be one of several species. The main contenders were: *Lycopus australis* or the commonly cultivated *L. europeus*. Currently all other Australian records are of the native species *Lycopus australis* R.Br. (Australian Gypsywort). This species occurs in wetlands in South Australia, Victoria, Tasmania, New South Wales and Queensland (Conn 1999). Neither this genus nor this species has been recorded in Western Australia.

To identify the plants present at Albany, I used the only current world wide revision of the genus *Lycopus* (Henderson 1962).

*Lycopus australis* has stem leaves that are oblong to narrowly elliptic-lanceolate, evenly and sharply serrated with forward extending teeth and white small flowers. *Lycopus europeus* has stem leaves which are narrowly lanceolate to ovate, but coarsely toothed with a few shallow rounded lobes at the base (Fig. 1), with the stems and veins of leaves generally densely pubescent, but can also be glabrous. The larger flowers of *L. europeus* have the lower lip three lobed with at least the central largest all bearing a red nectar mark (Fig. 2). The population at Albany fits *L. europeus* in both leaf and flower characters.

*Lycopus europeus* (Gypsywort or Water Horehound) is the most widespread species in the genus being found in Europe, North Africa and northern Asia. It is widely cultivated as a medicinal herb used for coughs, respiratory disorders, sleeplessness and hypothyroidism (Al-Snafi 2019). No doubt this is how it entered Western Australia. The species is naturalised in New Zealand, South America, North America, and probably in South Africa

**Figure 1**. Whole plant of *Lycopus* from Albany showing broad shallowly toothed leaves. Photo: Greg Keighery.

**Figure 2**. Flowers of *Lycopus* showing red nectar guides. Photo: Greg Keighery.

(Randall 2002), but is not currently recorded as naturalised in Australia.

*Lycopus australis* despite being widespread elsewhere in eastern Australia is a conservation listed species in Tasmania (Tasmanian Threatened Species Link 2020). Currently in this listing the species is regarded as having no other members of the genus present in Australia. However, this report suggests that the European species which occupies the same habitat, could be regarded as a potential threat to this Australian native.

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